Estimates of Emission Effects and Their Potential Uses in Energy Modeling

Dallas Burtraw

Resources for the Future

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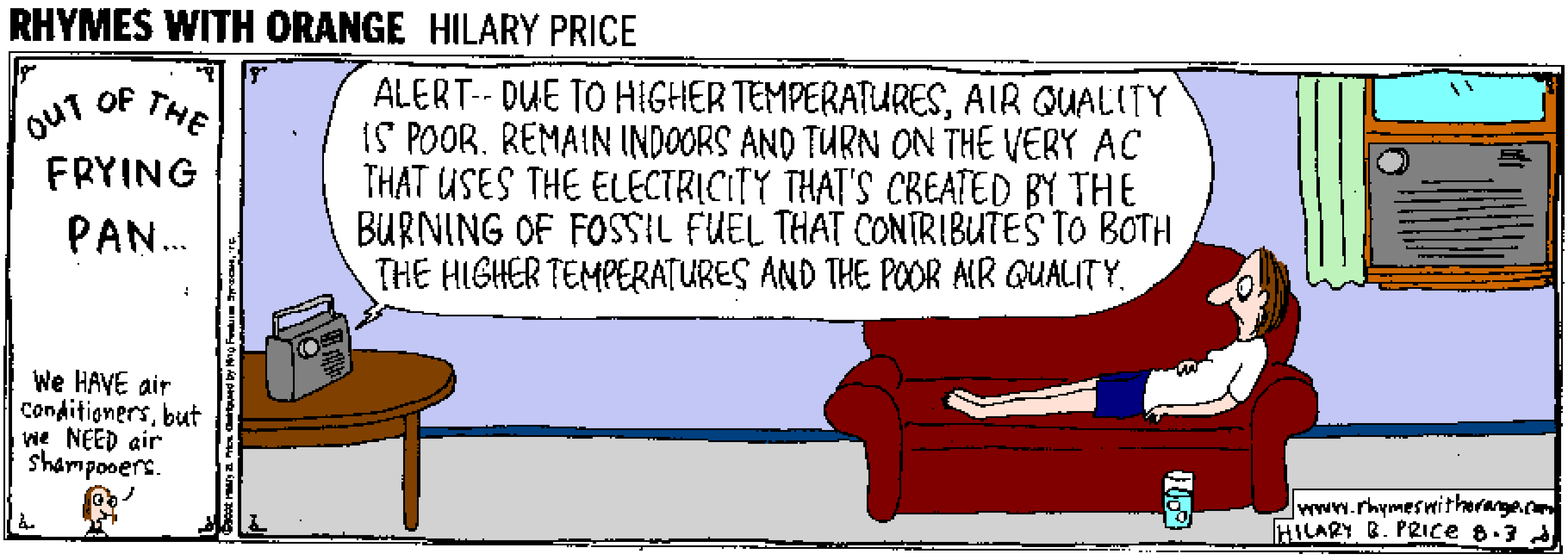
Roadmap

- **Context**
- **What Could Be Done?**
  - **Damage function approach now well understood**
  - **Mega models versus Integrated Assessment Approach?**
- **What Could Go Wrong?**
- **Why Is It Useful Anyway?**

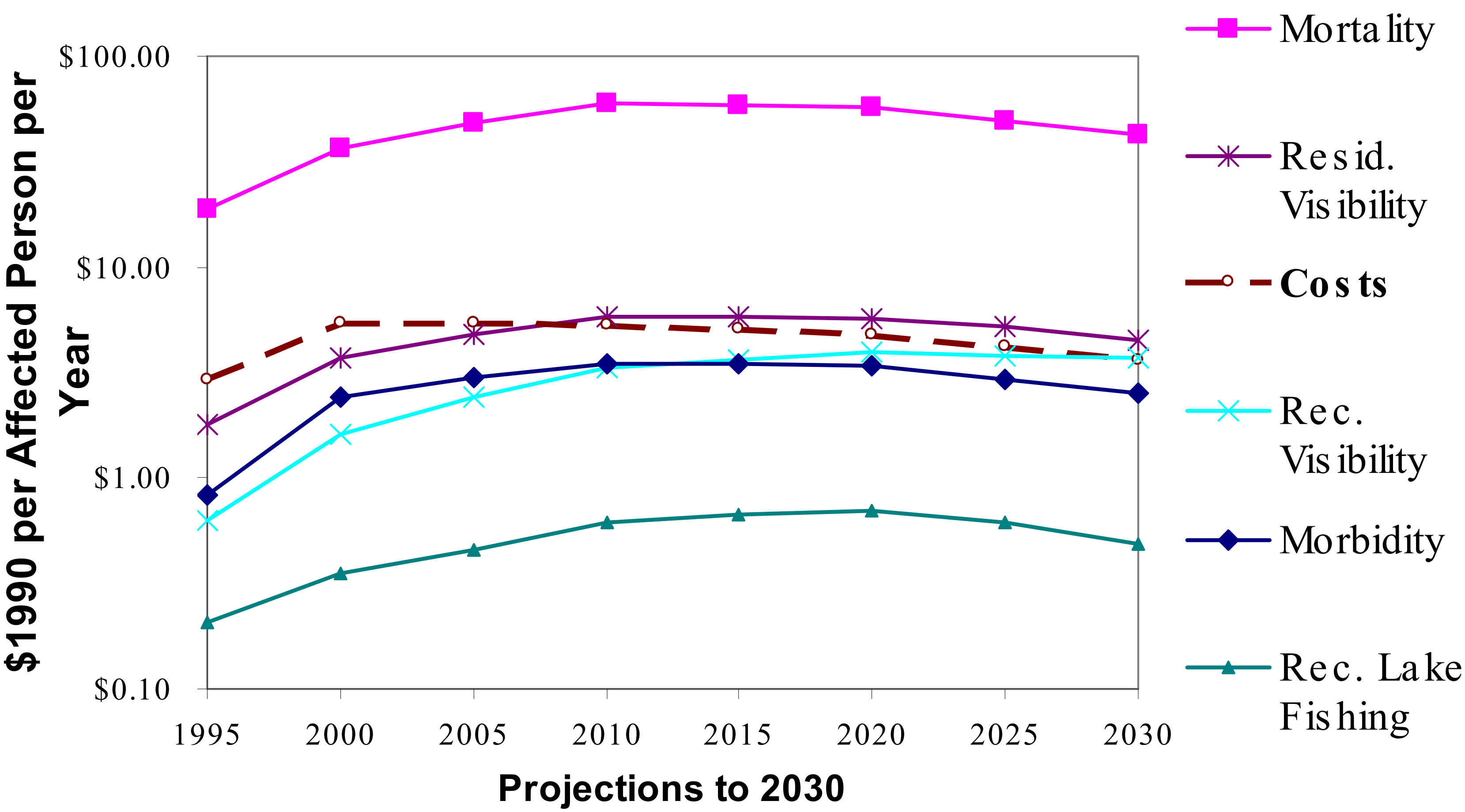
Context of the Problem



What Could Be Done?

- **Distinction between models for regulatory support and those for regulatory development, planning and policy analysis.**
  - Linkage of full-form mega-models is expensive, inaccessible.
  - Focus on regulatory (litigation) support can stifle model development, policy planning and the use of models in negotiation.
- **Hence the call for integrated assessment & reduced-form modeling linking energy and environment models to support policy planning and development.**
  - Full-form models with "internal" validity; integrate through reduced-form modeling
  - Emphasis on "external" integrity
  - Account for correlated uncertainty
  - Include assessment
  - Value of additional information
- **Reduced-form exposure, epidemiology, valuation modeling make off-the-shelf analysis possible for energy modelers.**
  - Examples: Exmod, TAF, Harvard, RiskPoll

Example: Tracking and Analysis Framework
Benefits and Costs of Title IV



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"Integrated Assessment" (NAPAP, 97) and
"Benefits and Costs of Title IV" (CEP, 98)

Value of Information:

The Weak Links Between Science and Economics

Categories ● high ⭘ high-mid ◒ mid ⊙ low-mid ○ low	1. Link Between Science and Economics: Are benefit endpoints well established? Does science provide infomation needed for economic analysis?	2. Economic Methods: Are economic methods adequately developed?	3. Data Availability: Is data available from science and from economics for an assessment of benefits?	4. Expected Benefit: Are expected benefits large?	5. Value of Additional Information: With the goal of improving benefit estimates, what is the relative short-term return on investment?
Health: Mortality	⭘	⭘	⭘	●	●
Health: Morbidity	⭘	⭘	⭘	⭘	⭘
Visibility	⭘	◒	⊙	⭘	⭘
Materials / Cultural	⊙	◒	○	⭘	⭘
Nonuse Value: Ecosystem	⊙	⊙	⊙	●	◒
Aquatics: Recreation	⭘	●	⊙	⊙	◒
Forests: Recreation	⊙	⭘	○	⊙	◒
Ag. / Comm. Forestry	⭘	●	◒	◒	⊙
Radiative Forcing	⊙	○	○	⊙	○

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“Benefits and Costs of Title IV” (CEP, 98)

Value of Information

- **Where is the greatest value of additional information?**
- **Epidemiology and willingness to pay (WTP) are probabilistic within linear model absent thresholds. In a linear model E[f(x)] = f[E(x)]**
- **…But, electricity system and exposure models are nonlinear.**
- **State to state receptors too coarse, but is very tight grid relevant for policy analysis or only litigation support?**

Major Research Issues and Uncertainties in Valuation of Health-Related Benefits

Exposure Modeling

- Source apportionment:
  Who is to blame (location and types of sources)?

Epidemiology

- Long-term exposures and disease.
- Which particulates matter?

Valuation

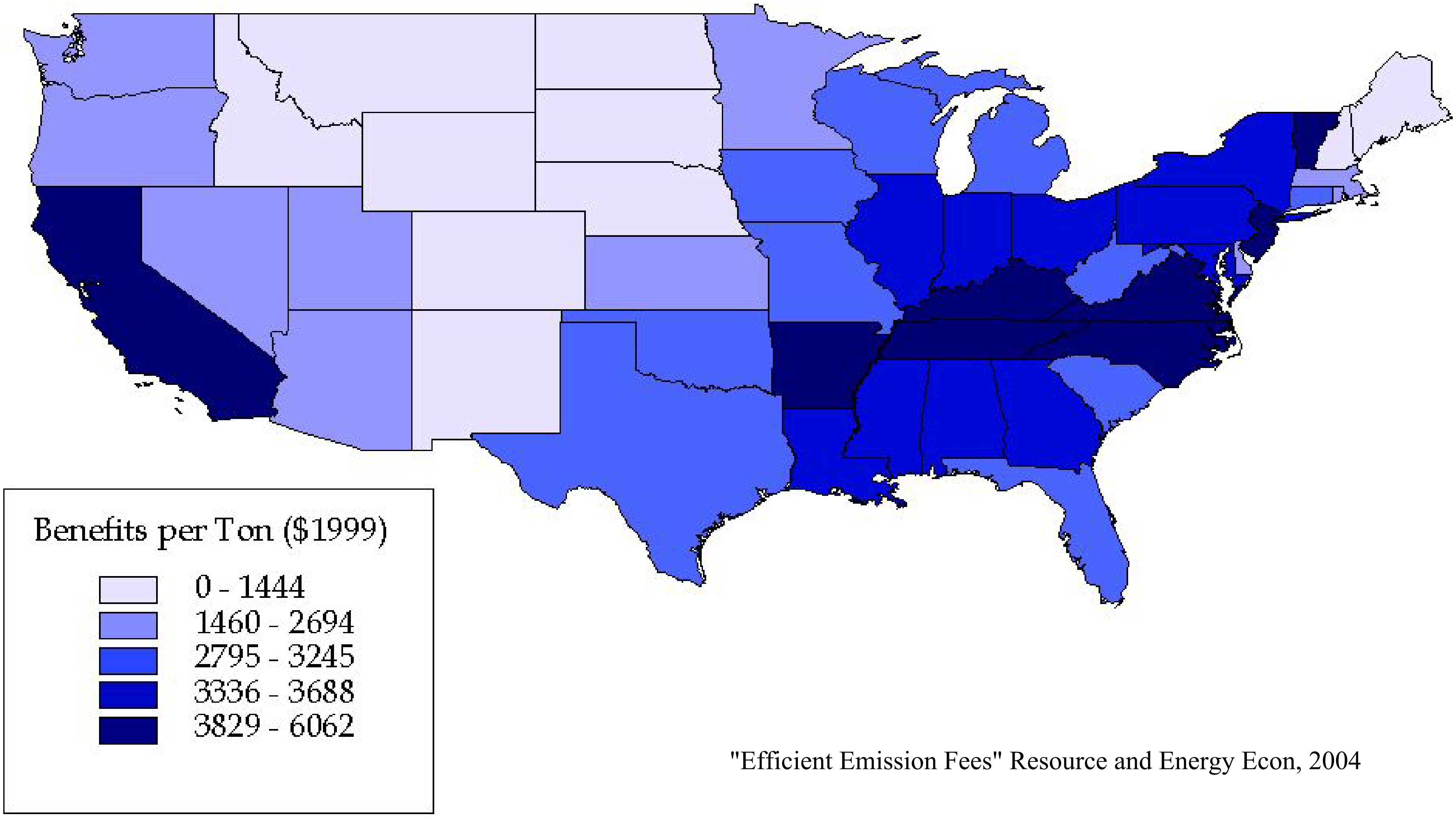
- Valuation of children and elderly and other vulnerable groups. Evidence suggests:
  - ✓ Parents value childrens' health > own health.
  - ✓ Seniors value selves < younger adults… But far greater than Life-Year-Lost approach suggests.

What Could Go Wrong?

1. The question of the 1990s Social Costing efforts: "What is the value of a ton?" (sic) is ill-defined

- Location, stack height, season, time, geography matter to exposure and the value of an externality ($/ton or $/kwh)
- Critics pointed to inconsistent monetary values ($/kwh) among states, and prompted many states to survey the literature to select consensus externality estimates
- But **consistent analytical methods** implies **inconsistent values** among states!
- DOE, the European Commission and some states (NY, Wisconsin) funded high quality studies

Example: The value of SO_2 Emission Reductions Vary by State



"Efficient Emission Fees" Resource and Energy Econ, 2004

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What Could Go Wrong?

2.Identifying the proper margin depends on policy context

- **Does policy target new and existing generation?**
  - TAF analysis found air-health pathway the most important (existing sources)
  - DOE fuel cycle project found other pathways significant (especially for new sources)
  - ➢ Up to an order of magnitude difference in externality estimates between existing and new sources
- **Competition in new generation between gas & renewables**
  - ➢ Determination of the technology that is backed out by new renewables requires detailed modeling

What Could Go Wrong?

3. Exclusion of non-health pathways can be significant

Hypothetical scenario:
Five-axle semitrailers carry 48,000 pounds of coal along thirty miles of public highway.

Factors to consider in calculating damage to roadways ($/Mwh):

- Axle configuration
- Weight
- Pavement type
- Resurfacing cost
- Btu content
- Heat rate
- Distance

Another Example: *Fiscal Benefits*

Hypothetical scenario:

Embedded taxes inflate the cost of electricity above the social opportunity cost of resources. Taxes vary among fuel cycles.

Factors to consider:

- profile of inputs of production
- embedded taxes in inputs of production
- utility paid taxes
- offsetting “direct benefits”
- relative marginal cost of funds (deadweight loss)

Fiscal "Benefits" of Technology Choice for New Electricity Generation

EAST (mills/kWh)	Direct Taxes	Fuel and Embedded Taxes	Total Taxes	(Percent of LCOE)
Gas	3.10	1.97	5.07	14.4%
Coal	8.30	5.03	13.33	20.7%
Wind (w/o REPC)	8.30	2.80	11.10	20.0%
Biomass (w/o REPC)	7.40	7.81	15.21	32.4%

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"Fiscal Effects of Electricity Generation Technology" RFF DP 95-16

What Could Go Wrong?

4. When marginal damage is, is not, or is only partially an externality depends on policy context

- Transboundary effects?
- What is the regulatory environment?
  - ✓ compensating wages
  - ✓ incentive based regulations
    - emission fees
    - fixed quota (permits)
    - liability

Example:
Adjustments for Second-Best Considerations

QUESTION: Is a useful rule of thumb

COST ADDER = EXTERNALITY

…or is some adjustment necessary?

In a normative model, the "optimal adder" depends on:

- marginal social cost of generation
- marginal social cost of alternatives
- the opportunity to bypass utility
- sensitivity of demand to price

"Optimal Adders" JEEM 1995

Example Adjustment Factors for a Mid-Atlantic Utility

Adjustment factor (θ) found to equal:

commercial sector	.97
residential sector	.88

Conclusion: Adjustment necessary *unless:*

- price is close to marginal cost
- elasticity of demand is small, *and*
- reference and bypass technologies are similar

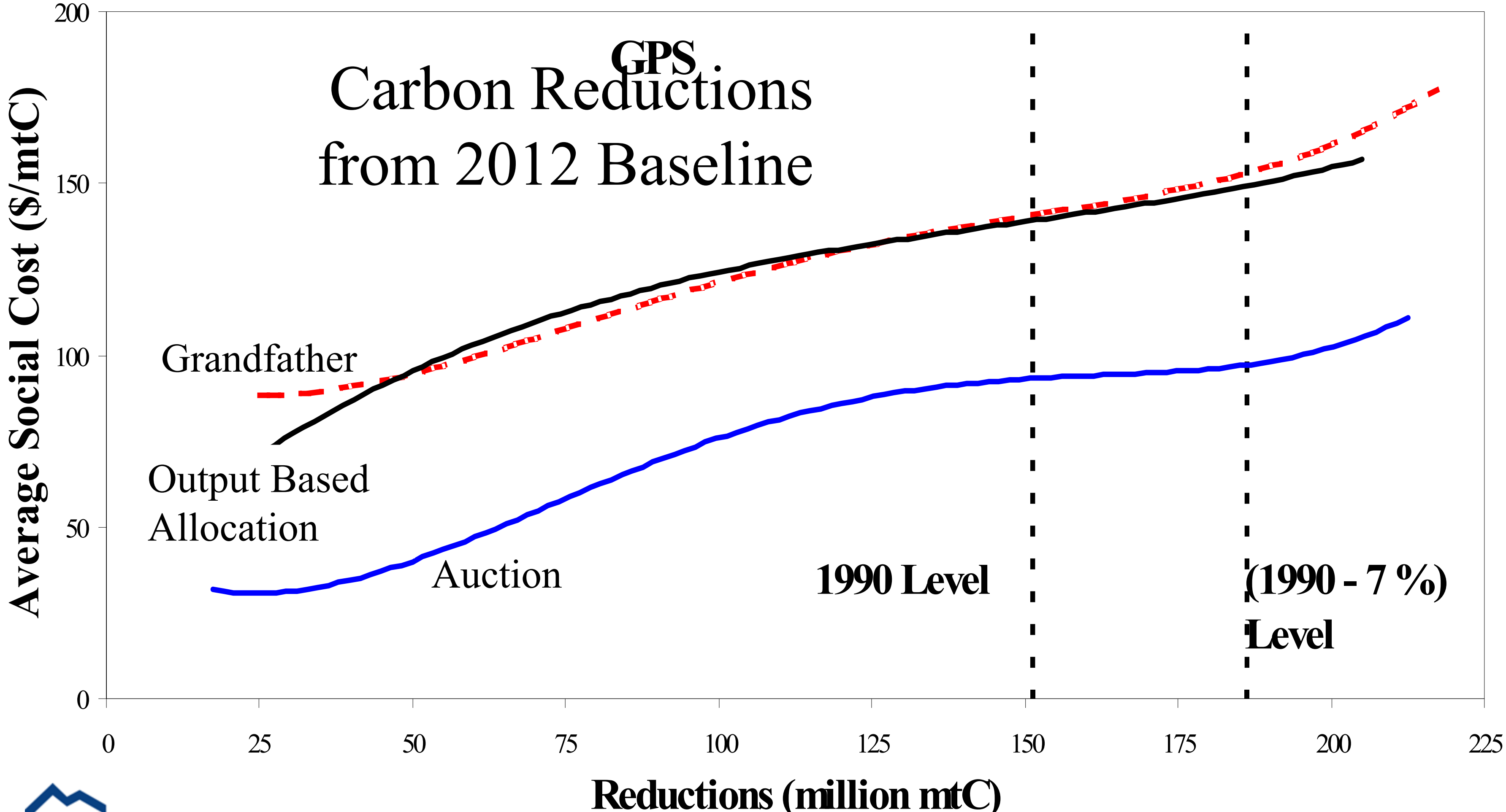
Note: Different values obtain in considering different policies (taxes, adders, tradable permits)

"Second-Best Adjustments" Land Econ. 1997

What Could Go Wrong?

5. Emission responses vary with policy

Example: Initial permit distribution affects the abatement cost of achieving an emission target



"Allowance Allocation for Carbon", RFF DP 01-20

In spite of problems… Why Is Integration of Energy and Environmental Models Useful?

Command and Control Leads to an Inadequate Internalization of Social Cost (cents per kWh)

	Clean Technology	Dirty Technology (unabated)	Dirty Technology (w/ abatement)
Private Costs of Generation	**5**	**3.5**	**3.5**
Private Costs of Abatement			**1**
External Cost of Residual Pollution		**2.5**	**1**
Total Private Financial Costs	**5**	**3.5**	**4.5**
Total Social Costs	**5**	**6**	**5.5**

Why Is Integration of Energy and Environmental Models Useful?

- **Value of information for model development and research priorities**
- **Policy analysis - Findings of relative magnitudes of values, even within an incomplete modeling framework, provides useful data to policy debate.**

Conclusion

- Excluding externalities is inappropriate, but getting reasonable values is difficult.
- Air-health appears most important in many circumstances but other pathways, including non-environmental concerns, are critical.
- The reasonable answer (value) in a policy model depends on question (policy and regulatory context).
- Hence, the mega-model may not be as useful or transparent for policy analysis, and certainly is not as accessible, as integrated reduced-form models.